# Chapter 4.  California Tiger Salamander

*Review Conducted by:*

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## SUMMARY

We reviewed the biological impacts of the Phase II expansion project and the proposed mitigation on existing populations of the California tiger salamander (*Ambystoma californiense*) (CTS) at the landfill site.  We first identified all viable breeding areas at the site, based on our own field surveys of late-season larval samples in all existing wetlands, and on previously reported larval and adult surveys.  We then developed a quantitative model for mitigation that considers the biological value of each acre that will be lost and each acre proposed for mitigation at the site. We evaluated the proposed mitigation using a biologically realistic habitat valuation model we developed for CTS from empirical field data.  Our analysis demonstrates that the proposed mitigation does not balance the lost biological value of the Phase II expansion, and it does not lead to a net increase in CTS habitat value.  We propose alternative scenarios that could improve the habitat value of the existing mitigation properties and discuss the alternative option of acquiring additional acreage to help mitigate the lost biological value of CTS.

## INTRODUCTION

### Background

The Landfill proposes to expand its operations into a Phase II expansion project.  This project will substantially impact the biological resources in the area, both by covering a 193.8-acre parcel with landfill material and by isolating certain fragments of the property from others, thereby restricting the use of some of the remaining, unimpacted land.

Our role in this project was described in the Scope and Schedule provided to the senior author (Appendix A; see Chapter 1 for additional information on the scope of the review efforts as defined by BCDC). As academic biologists, we elected to conduct our portions of the review pro bono and have not been compensated or reimbursed for any time or expenses incurred during this project. Shaffer is an expert on California amphibian and reptile biology, with a particularly strong emphasis on the biology and conservation of the CTS. Searcy is a graduate student (Ph.D. program in Population Biology) working under Shaffer on the community ecology of CTS, both in its aquatic and terrestrial stages.

## Scope of Review

The Central Distinct Population Segment of CTS is listed as Threatened under the federal Endangered Species Act, and previously has been documented to exist on the Landfill site (ESP 2002). It is also a Species of Special Concern in California (DFG), and is being considered for state listing. Particularly because of recent work on terrestrial habitat use by the CTS (Trenham et al. 2001, Trenham and Shaffer 2005), Shaffer was brought onto the team to document the use of the site by CTS, and to use the best-available science to evaluate impacts and proposed mitigation efforts on salamander populations. Our scope did not include a review of impacts of the project on reptiles and other amphibians. However, we are willing to offer comments on these species, if requested.

## Review Objectives

Our overall objectives were to determine the use by CTS of breeding ponds on the Potrero Hills Phase II expansion site and proposed mitigation areas, evaluate the impact of the expansion project on both aquatic and terrestrial salamander habitat, and evaluate the effectiveness of proposed mitigation. To accomplish this analysis, we used GIS layers and our newest data from the nearby site at Jepson Prairie Preserve (Shaffer and Searcy unpublished data, which augments data from Trenham and Shaffer 2005) to estimate the combined biological impact on CTS populations of (1) losing the proposed Phase II expansion land, and (2) protecting the proposed mitigation land. In this way, our goal was to provide a clear, biologically based evaluation of whether or not the proposed mitigation is sufficient to offset the proposed losses of habitat to the salamander.

Our strategy fully embraces the USFWS goals for developing mitigation credits, which states that "the credit system for a conservation bank should must be expressed and measured in the same manner as the impacts of the development projects that will utilize the banks…. The method of calculating bank credits should be the same as calculating match project impact debits." (USFWS 2003, p. 10). The USFWS goes on to recommend that "Every conservation banking agreement should specify the methods for determining credits within the bank and debits outside the bank…" (USFWS 2003, p. 11), and our method seeks to specify this in a quantifiable manner.

Specifically, we sought to:

- Identify CTS breeding ponds that were used at the site in 2006 and compare results to data provided to us from a previous breeding site evaluation (ESP 2002).

- Evaluate the effects of the proposed project with a primary goal of evaluating the effects on CTS terrestrial habitat use.

- Evaluate the proposed mitigation program, primarily to determine under a biologically reasonable set of assumptions whether the proposed mitigation will compensate for the loss of habitat to the metapopulation of salamanders on the site.

- Identify potential modifications or implementation measures for incorporation into the landfill expansion. Here, our main goal was to evaluate the biological value to CTS of the acreage that would be lost and the acreage that would be "gained" through mitigation. Depending on the mitigation ratio to be required by the USFWS, DFG, and other agencies, the gain in acreage typically must outweigh the loss by a factor of 2:1 or 3:1. If there is a net loss in biological value, then we identify this as a clear problem. We also comment on certain other aspects of the proposed mitigation plan.

- Identify potential modifications to the mitigation program to more effectively offset for potential effects of the project.

## METHODS AND MODEL DEVELOPMENT

We conducted surveys for larval CTS using standard seining sampling in all aquatic habitats at the Landfill Phase II expansion site, mitigation areas, and the adjacent Eastern Valley property. This area has, or had, seven potential breeding sites for CTS, numbered ponds 1–7 (see Figure 6 of the MMP [ESP and LSA Associates 2006]). These sites were surveyed by LSA Associates on April 13, 2000; March 30, 2001; and April 8, 2003; and again by Shaffer and Searcy (accompanied by Tim Lacy of LSA Associates) on May 23, 2006. All survey efforts by Shaffer and Searcy were authorized by USFWS, under an Endangered Species Act Section 10A(1)b permit issued to Shaffer.

We used a 15-foot-long seine to sample for larvae. Our surveys occurred rather late in the season (i.e., CTS generally breed in December/January and metamorphose in May–July; Shaffer and Trenham 2005, Trenham et al. 2000). Therefore, we were sampling for large larvae that are generally easy to capture in small pool habitats. We sampled until we had caught a minimum of 30 larvae, except where none were caught in five seine hauls, at which point we stopped sampling. We clipped small pieces of tail from each larva (retained for future genetic analysis) and assigned the population of each pond to one of the following abundance categories:

- Abundant = at least 10 larvae in an ~20-foot seine haul; many hundreds (or more) presumed to occur in the pond.
- Present
- Not Abundant = 1 to 9 larvae per seine haul; probably less than 100 individuals present in the pool.
- Absent = no larvae caught during at least five seine hauls, and 50–100 percent of the surface area of the pond sampled; if larvae are present, probably less than 10 occur in the pool.

We also collected data on the approximate size and depth of the breeding sites.

We walked some areas of terrestrial habitat, but the secretive nature of adult and sub-adult CTS makes it virtually impossible to use visual occurrence to evaluate the suitability of the terrestrial habitat for the species. We noted areas with abundant ground squirrel and gopher activities, both of which are important components of CTS terrestrial habitat (Loredo et al. 1996, Trenham 2001, Shaffer and Trenham 2005).

## Impact Evaluation

**Biological and Analytical Assumptions.** Determining project impacts on CTS is a complex process that requires detailed knowledge to make a reasonable assessment. This is particularly true for terrestrial habitat, which we view as overwhelmingly important for this project. Any evaluation of impact and mitigation for terrestrial habitat loss rests on a series of biological assumptions. Assumptions we used are briefly discussed below:

(1) CTS migrate to and from breeding sites, and their distribution on the terrestrial landscape depends on distance from a breeding site, as well as the age of the animal. For example, both new metamorphs and breeding adults tend to concentrate more near breeding sites than do 1- to 3-year-old animals. Importantly, we can now estimate these age-specific density distributions based on capture data from nearby Jepson Prairie, Solano County (Trenham and Shaffer 2005, Shaffer and Searcy unpublished data).

(2) CTS move to and from their breeding sites in straight lines. We have only limited data to support this assumption, but it is a reasonable, simple assumption that is consistent with the results of our field studies in Monterey County. Under this assumption, the Phase II expansion area effectively blocks all movements (estimated as straight-line distances) from a breeding site to areas on the opposite side of the expansion area. For example, the Phase II area renders the Director's Guild parcel unavailable to CTS from pond 3, since there is no straight line access from pond 3 to the Director's Guild that does not cross the expansion area. The

same is not true for pond 2, however, where the expansion area blocks potential movement to some, but not all, of the Director's Guild lands.

(3) Animals of different ages have different values to the total population. Based on data collected over an 8-year period in Monterey County (Trenham et al. 2000) and our last 2 years of data at Jepson Prairie, we established a relative weighting scheme to assign population values to metamorphs, juveniles, and breeding adults (see below). This weighting scheme uses the probability of survival of each age class to breeding age. For example, new metamorphs have a relatively low value because of the substantial mortality that occurs prior to reaching breeding age, whereas breeding adults have the highest value.

(4) We can combine the survival-based weighting scheme with the density distribution of different age class animals across the landscape to calculate, for each breeding site (ponds 1, 2, 3, 4, 5, and 7), the reproductive value of each acre of land that is lost to the Phase II landfill expansion and the reproductive value of each acre of land provided by the Director's Guild, Griffith Ranch, and the Southern Hills mitigation parcels. We also calculated these values for the Eastern Valley area, even though it is not a designated mitigation area. For ponds 1 and 4 that are completely eliminated, we calculated the total value of a 1-mile circle of lost habitat, because that is the minimal distance that is currently considered occupied by the USFWS.

(5) We consider all other lands, including the Eastern Valley area (i.e., valley lands just east of the Phase II area) as unaffected—that is, as neither a benefit nor a loss to the salamanders.

(6) We did not include the power plant site in our calculations, since our most current information indicates that it will be placed within the Landfill Phase II expansion site footprint. We also did not include any quantitative predictions for the impact of the increased traffic from roads and construction equipment in our evaluation, since we do not have any real knowledge about the magnitude of such impact. We did not consider any other indirect effects on CTS. We also did not include the positive or negative effects on salamanders that may breed offsite (i.e., from breeding ponds that are not on the Phase II, mitigation, or Eastern Valley lands) but that may use these areas as terrestrial habitat. While inclusion of these effects would change our calculations somewhat, they are clearly minor compared to the effects of Landfill expansion to the Phase II area and the proposed mitigation parcels.

(7) Our calculations of habitat value are assessed on an acre-for-acre basis (i.e., we calculated the biological value of each acre that is lost and each that is gained through protection and possible enhancement). Final mitigation ratios are then needed to determine whether the proposed mitigation is adequate for what is lost. This ratio is not a predetermined value, and according to the USFWS varies depending on the region in question. Given the rarity of high-quality habitat in

the Bay Area, we prefer a 3:1 ratio, although a value of 2:1 is mentioned in the supporting documentation.

(8) We informally consulted with the UFSWS to determine that our general approach was valid. We also clarified their policy on certain issues regarding mitigation lands. In particular, the USFWS clarified that any mitigation land must contain habitat that supports all aspects of the biology of a species to even be considered as valid mitigation acreage. In the case of CTS, that means that it must be immediately adjacent to, or have on it, protected breeding and upland habitat to be considered mitigation land. Therefore, the value of upland habitat was evaluated only in relation to its distance and connection to those ponds protected within contiguous mitigation lands.

(9) **Details of the Evaluation Method.** Our assessment of the biological value, or population value, of land around a pond is based on 2005–06 data from Olcott Lake, Jepson Prairie Preserve, Solano County. This site is about 10 miles northeast of the Landfill project and is the most actively-studied site for CTS terrestrial habitat use in the species' range. The 2005–06 year data set consists of a total of 8,402 captures, making it a robust study on which to base our analysis. Our strategy was to take the density distributions of each recognizable age class (i.e., new metamorphs, juveniles, and sexually mature adults) at Olcott Lake and apply those distributions to the landscape at the Landfill project. We then weighted these distributions based on the relative reproductive values of their respective age classes to come up with a total loss or gain in population value of habitats for each proposed action (Phase II development and mitigation designation).

The relative reproductive value of an adult was set at a value of 1.0, and the relative reproductive values of the other age classes was assigned as their probabilities of surviving to maturity. These probabilities were calculated based on data from Trenham et al. (2000), who gives the average age to maturity for CTS as 4 years, with 30 percent surviving during the first year and 55 percent surviving during each subsequent year. Based on these values, we calculated the relative reproductive value of an average juvenile as 0.37 and the relative reproductive value of a metamorph as 0.08. The density distributions of the different age classes at various distances from Olcott then were weighted by these relative reproductive values and added together to produce a density distribution of reproductive value as a function of distance from the shoreline of a pool (Figure 4-1). By integrating this curve, one can determine the size of the reserve one would need to create around a pool in order to protect a certain fraction of the reproductive value of a salamander population. The percentage of the reproductive value of the population that is protected is in turn directly correlated with the future viability of the population.

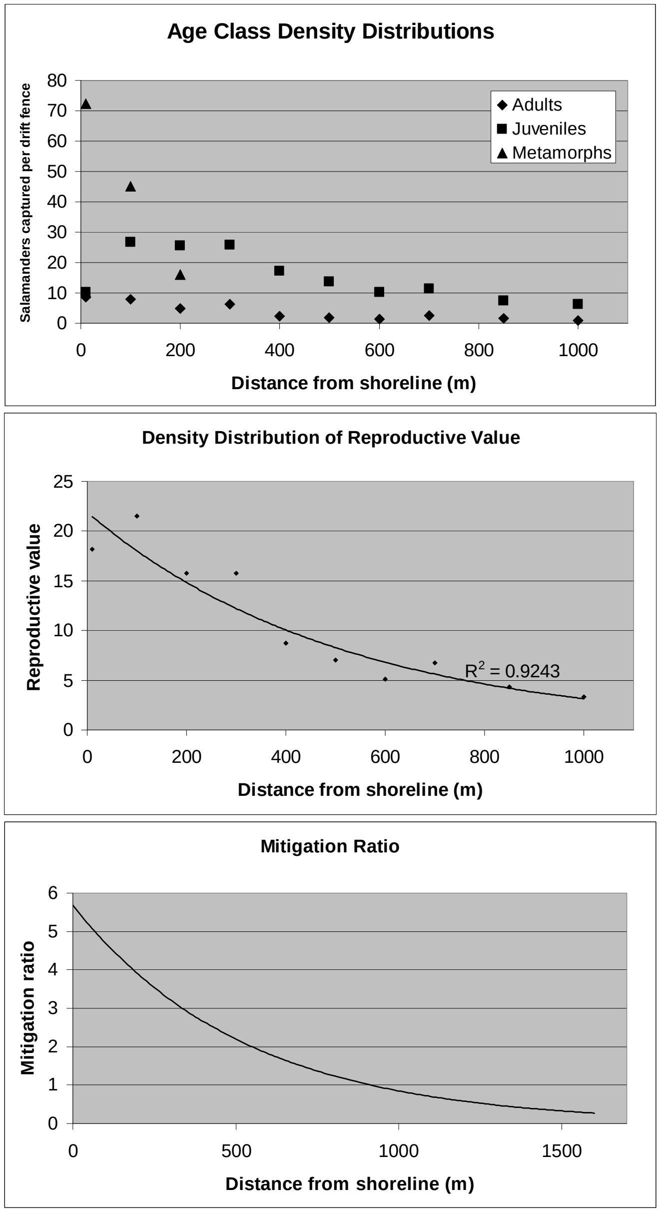


**Figure 4-1. Methodology for Calculating the Distance Curve of Proposed Mitigation Ratios.** Calculations are based upon the density distributions of the three age classes (metamorphs, juveniles, and adults) captured at Olcott Lake, Solano County during the 2005–2006 wet season (top panel). These density distributions were then weighted by multiplying them by their relative probabilities of reaching maturity (i.e., metamorph = 0.08, juvenile = 0.37, adult = 1.0) and added them together to give the density distribution of reproductive value (middle panel). This density distribution shows the relative value of land at different distances from the shoreline in contributing to maintenance of the salamander population. A curve of mitigation ratios (bottom panel) was generated with the same shape as the density distribution of reproductive value, so that land at various distances from the shoreline of a breeding pond have the same relative values as mitigation habitat for a salamander population. The magnitude of this curve is such that if one had to mitigate for all of the land within 1 mile (1.6 km) of a breeding pond, it would require the same amount of land as would be required with a 1:1 mitigation ratio applied to all lands within 1 mile of a breeding pond.

The density distribution of reproductive value shows how valuable each acre of land is to the salamander population at various distances from a breeding site—that is, it indicates the biological value of land (or at least one important component of the biological value) as a function of distance from a breeding site. In order to make this curve meaningful for resource managers, we have converted it into a curve of mitigation value that reflects this distribution of biological values. Thus, our proposed mitigation value curve (Figure 4-1) has the same shape as the density distribution of reproductive value, assigning relative mitigation values to lands at various distances from a breeding pool that are equivalent to its relative biological value to a salamander population.

The height of the proposed curve of mitigation value is important. In Figure 4-1, we chose to scale the entire curve such that the total value of mitigation land (i.e., the total area under the curve) within 1 mile of a pond is equal to the total mitigation value for that same mile under a 1:1 constant mitigation ratio. Thus, the area under the curve is identical to the area if one were to accomplish a 1:1 mitigation ratio for all of the land within 1 mile of a vernal pool without any biological weighting considerations. Therefore, the total mitigation required under the current USFWS strategy, and our strategy, is the same. However, that total mitigation value is radically redistributed under our plan, so that the mitigation ratio is much higher for land that is densely inhabited by high-value (i.e., older) animals and much lower for land that is sparsely populated by low-value animals. An important aspect of this strategy is that the same mitigation index is used both for land that will be lost and land that will be gained through mitigation. This equivalency is critical, for it allows us to evaluate the gains and losses of each parcel in an unbiased, biologically meaningful way. We also note an important point, which is that we here define "gains" in a very specific way. If an acre of existing land that is already occupied by salamanders is protected in perpetuity as habitat, we consider that a 1-acre "gain". Thus, if 2 acres of land are owned by a developer, and 1 is destroyed (lost) and the other is placed into permanent mitigation (gained), we view this as no net loss, rather than a 50% net loss (2 acres of habitat are reduced to 1 protected acre). We do so in an effort to view the mitigation proposed by the Landfill in its best possible light, fully recognizing that this may not be in keeping with general guidelines for mitigation. In addition, **the scheme represented in Figure 4-1 does not take into account the mitigation ratios currently used by the USFWS**, which are *always* greater than 1:1 (in our experience, 3:1 is the standard ratio, but according to the USFWS, it depends on the area under consideration). To go to a 2:1 or 3:1 ratio, one would multiply the Y-axis for "debits" due to lost land by two or three, respectively.

Why do we go through all of these calculations, rather than simply use a preset 2:1 or 3:1 mitigation ratio for lost land in the expansion area? The reason is that our strategy allows us to make evaluations that are much more biologically based than a single simple ratio and to apply them objectively to each acre being lost or protected through mitigation. It also emphasizes that not all acres are equal, and that the precise configuration of impacted and mitigation land is critically important.

We applied this formula for each occupied pond to the land lost to the Phase II expansion area and to the land protected by mitigation (Director's Guild, Griffith Ranch, and Southern Hills) to evaluate the effectiveness of proposed project mitigation. We present these results below under "Direct Project Effects."

## Mitigation Evaluation and Recommendations

We note that our mitigation evaluations are somewhat approximate. We did not include all impacts (see "Direct Project Effects" below), and we assumed that all terrestrial habitat differs only with respect to distance to a breeding site (a very reasonable approximation). As discussed previously, we also did not address the potential values of project lands to salamanders using off-site breeding pools. Given that these off-site lands are not currently protected, this is in accordance with current USFWS policy, to the best of our knowledge.

# IMPACT EVALUATION

This section reports on results of field surveys and analysis of habitat evaluations conducted for the Phase II and mitigation sites.

## Pond Survey Results for CTS

Our survey results are summarized in Table 4-1, along with previous survey results.

Because CTS do not breed every year at every site, and breeding and metamorphosis dates vary among years, we did not use larval densities as a basis for characterizing the quality of the sites, although we note whether larvae were "abundant," "present/not abundant," or absent. However, for our calculations, we simply considered sites as "occupied" or "unoccupied." Based on LSA's observation of adults at pond 6, we could have considered it occupied; but the absence of larvae in surveys by both LSA and us suggests that it may not be used regularly by CTS for breeding, and we did not include it as a breeding site. In addition, we did not separately sample pond 3A because it appears to simply be a spill-over from pond 3, and we consider it to be biologically a part of pond 3.

In summary, our evaluation of habitat occupancy by CTS is similar to that portrayed in the MMP—that essentially all ponds constitute breeding habitat for CTS, and that all terrestrial habitat is utilized by metamorphosed CTS. However, we considered pond 6 to be unoccupied for our calculations, because it appeared to us to be a very marginal breeding site.

At a somewhat broader level, our field work indicated to us that the Potrero Hills site constitutes fairly "normal" CTS habitat. It lacks any large, completely natural vernal pools that constitute the most important CTS breeding habitat, but the fact that it is currently an intact set of interconnected ponds (i.e., within the typical dispersal distances of salamanders) with contiguous terrestrial habitat makes it more important than an equal amount of acreage with isolated breeding pools.

**Table 4-1. Relative Abundances of Previous and 2006 Surveys for California Tiger Salamanders in Ponds within the Potrero Hills Phase II Expansion Area and Adjacent Proposed Mitigation Lands**

| Pond | Surveys by LSA Associates 2000–2001 and 4/8/03 | Surveys by Shaffer and Searcy 5/23/06 | Notes |
|---|---|---|---|
| 1 | Adults seen in 2001; larvae present/not abundant in 2003 | Abundant larvae | |
| 2 | Larvae present/not abundant in 2001; no larvae in 2003 | No larvae | |
| 3 | No larvae in 2001; abundant larvae in 2000 and 2003 | Abundant larvae | |
| 3A | Larvae present/not abundant in 2001; larvae absent in 2003 | | Pond nearly dry when sampled in 2003; not directly sampled by Shaffer and Searcy because considered a part of pond 3 |
| 4 | Larvae present/not abundant in 2000–2001 | No survey | Pond was eliminated between survey periods |
| 5 | Abundant larvae in 2000, 2001, and 2003 | Abundant larvae | |
| 6 | Adults but no larvae seen in 2001 | No larvae | Pond almost dry at 2006 survey |
| 7 | Adults present in 2001; abundant larvae in 2003 | Abundant larvae | |

Note: See ESP 2002 and Lacy 2003 for details on LSA's results.

## Direct Project Effects

**Habitat Loss.** The Phase II expansion would result in two direct impacts: loss of aquatic breeding habitat (ponds 1 and 4) and loss of terrestrial habitat. In this evaluation, we assumed that the terrestrial habitat is currently at its carrying capacity, and therefore that adding more ponds (above the existing number) will not substantially increase the total number of breeding adults on the site. We make this assumption based on pragmatic, empirically based science. We know, based on multiple years of survey data, that most ponds onsite are regularly used and support salamander breeding, and we therefore assume that they each contribute equally and additively to the recruitment pool of breeding adults. However, we have no such information for any potential replacement pools—they might be used as breeding sites in the future; if they were, they might contribute more adults to the overall number of breeding adults—but they also might not.

Given that no new ponds have been constructed to replace the old ones, and that no adult censuses have been conducted, we simply assume that the system is working at capacity right now. By this logic, if ponds are destroyed (for example, ponds 1 and 4), they could, in principle, be replaced, **up to the current density of ponds per acre of upland habitat that now exists at the site**, since that would bring the system back to its current capacity. However, it is impossible to evaluate the “credit” that might be gained from such replacement ponds for two reasons. First, we would need to know that such “replacement ponds” function as breeding ponds—that is, that they hold water for the appropriate length of time, that they do not become invaded by exotic predators, and that CTS use them as breeding habitat that results in successful recruitment. Second, we would need to know their exact placement on the landscape to calculate their added mitigation value. Given that we have no data to work with, and that no replacement ponds have been constructed, we do not include such “potential ponds” in our calculations. We do note that replacement ponds have been proposed (for example, on the Griffith Ranch property) and that they could certainly make up for some of the losses created by the removal of ponds. However, we would want to model these proposed ponds and recalculate the gains and losses incurred by these plans.

The effects of the expansion area and the values of the mitigation areas are summarized in Table 4-2. The habitat values for the project lands and each mitigation area (and the adjacent Eastern Valley property) are shown for each breeding pond and summarized across all ponds. Table 4-2 shows several calculated values which we explain in more detail here. The **deficit wedge** for a breeding pond is the number of “acre equivalents” lost for that pond as a function of the proposed Phase II expansion. To calculate it, we extend a “wedge” from the pond to the edges of the Phase II expansion, and consider both the actual habitat lost to the Phase II expansion and the habitat that is in the “shadow” of the expansion, up to a mile from the breeding pond. However, some of the land in that shadow may already be destroyed. For example, it might be that some of it was already lost to the Phase I part of the Landfill project. The **credit wedge** calculated the fraction of the deficit wedge that is not current habitat, using the same function as was used for the deficit wedge. (The credit wedge is simply our calculation of the acreage within a deficit wedge that was not appropriate habitat due to previous habitat modifications.) When the deficit wedge and credit wedge are summed, we have the total cost (i.e., gain or loss) for that pond as a result of the Phase II expansion. Thus, for Pond 1, the deficit wedge results in -2,066.978 lost acre equivalents of biological value, but the credit wedge adds back 414.93 acre equivalents of biological value, resulting in a net loss of -1,652.048 acre equivalents. Summed across the six ponds, we calculate a total cost of -5394.271 acre equivalents that must be recovered with the proposed mitigation lands ***in order to result in a 1:1 replacement***.

Now, consider the credit derived from the proposed mitigation. As currently configured, the Director’s Guild does not contain any known breeding sites (and never has), and it is not contiguous with any protected CTS habitat. According to our conversations with the USFWS, the Director’s Guild cannot therefore be considered mitigation for CTS, since it does not provide for both parts of the life cycle of the species. We therefore did not include the Director’s Guild in our “credit” calculations. However, we note that, since it is quite distant from any of the remaining ponds, it would not add much credit value to our calculations even if the USFWS allowed it to be included, because it contains no known breeding sites, unless a breeding pond could be created, which is not proven. Absent a

**Table 4-2. California Tiger Salamander Habitat Values for Landfill Expansion, and Proposed Mitigation Areas, and Adjacent Eastern Valley Lands as Mitigation (Units of Mitigation Value)**

| Pond | Mitigation Ratio Functions | Mitigation Cost (Equivalent Acres of Habitat Value)[a] | | |
|---|---|---|---|---|
| | | Subdivisions | | Totals |
| Pond 1 | $y = 5.651e^{(-0.0019x})$ | Deficit wedge | -2,066.978 | |
| | | Credit wedge | 414.93 | **-1,652.048** |
| Pond 2 | $y = 5.683e^{(-0.0019x)}$ | Deficit wedge | -573.583 | |
| | | Credit wedge | 57.344 | **-516.239** |
| Pond 3 | $y = 5.667e^{(-0.0019x)}$ | Deficit wedge | -896.375 | |
| | | Credit wedge | 73.662 | **-822.713** |
| Pond 4 | $y = 5.667e^{(-0.0019x)}$ | Deficit wedge | -2,061.646 | |
| | | Credit wedge | 237.992 | **-1,823.654** |
| Pond 5 | $y = 5.615e^{(-0.0019x)}$ | Deficit wedge | -590.953 | |
| | | Credit wedge | 44.31 | **-546.643** |
| Pond 7 | y = 5.464e^(-0.0019x) | Deficit wedge | -32.974 | **-32.974** |
| | | | **Total cost** | **-5,394.271** |
| Pond 5 | y = 5.615e^(-0.0019x) | Mitigation credit (excl. parcel E) | 708.239 | **708.239** |
| Pond 7 | y = 5.464e^(-0.0019x) | Mitigation credit (excl. parcel E) | 1,024.251 | **1,024.251** |
| | | | **Total credit (excl. parcel E)** [b] | **1,732.49** |
| | | | **Grand total (excl. parcel E)** [b] | **-3,661.781** |
| Pond 2 | y = 5.683e^(-0.0019x) | Mitigation credit (incl. Parcel e) | 850.762 | **850.762** |
| Pond 3 | y = 5.667e^(-0.0019x) | Mitigation credit (incl. Parcel e) | 873.365 | **873.365** |
| Pond 5 | y = 5.615e^(-0.0019x) | Mitigation credit (incl. Parcel e) | 1,144.988 | **1,144.988** |
| Pond 7 | y = 5.464e^(-0.0019x) | Mitigation credit (incl. Parcel e) | 1,234.836 | **1,234.836** |
| | | | **Total credit (incl. parcel E)** [b] | **4,103.951** |
| | | | **Grand total (incl. parcel E)** [b] | **-1,290.32** |

Note:

[a] Units are "acre equivalents" of habitat value, which are a measure of relative habitat value for lands in each area (see "Methods"). Negative values for Phase II lands indicate habitat values lost due to project construction. Values are accumulated independently for each pond to derive total gains and losses associated with each pond, each parcel, and a net value of directly impacted and protected mitigation lands.

[b] Parcel E is the Eastern Valley parcel that is neither slated for development nor for protection.

breeding pond, the Griffith Ranch also provides no mitigation since and it will be isolated from ponds 2, 3, 5 and 7 by development of the Phase II expansion. This means that, under current conditions, only the Southern Hills parcel provides upland mitigation, and only for ponds 5 and 7 (since they are actually within the protected mitigation lands). Their value in Table 4-2 is shown as "mitigation credit excluding parcel E" (parcel E is the Eastern Valley parcel that is neither slated for development nor for protection). The total mitigation credit is 1,732.49 acre equivalents. When the total deficit and credit are summed, the grand total is -3,661.781 acre equivalents.

Although we were not specifically asked to do so, we also did the calculations assuming that the Eastern Valley parcel (our "parcel E") was also fully protected and considered as mitigation land for CTS. These calculations are shown in the last four lines in Table 4-2. By adding in the Eastern Valley parcel, the grand total (including parcel E) results in a reduction in net habitat differences to -1,290.32.

It is important to remember that the values in Table 4-2 are for replacement at a 1:1 mitigation; to achieve a 2:1 or 3:1 mitigation ratio, the amount of cost "value" would need to be two or three times greater than that shown in the table.

Several key points emerge from this analysis:

- The effect of loss from Phase II is severe. Nearly two-thirds of that loss is due to the elimination of two breeding sites, ponds 1 and 4.
- Because of its position on the landscape, the Director's Guild provides no mitigation value to CTS breeding populations affected by this project. This has nothing to do with our calculations—rather, it reflects the existing policy for mitigation used by the USFWS.
- The Griffith Ranch site also provides no mitigation value, again because of its position with respect to the Phase II expansion.
- The Southern Hills parcel contributes substantial mitigation value (1,732.49 units) because of its proximity to, and inclusion of, ponds 5 and 7.
- Addition of the Eastern Valley parcel as a mitigation area (which is currently neither impacted nor proposed for mitigation) could add substantial habitat value (2,371 units of credit).
- Even with inclusion of the Eastern Valley parcel as mitigation, the habitat loss due to Phase II is still mitigated only to about three-quarters of its biological value.
- It is important to emphasize that our analysis includes only ponds and lands controlled by the Landfill, including the Eastern Valley parcel, that have been verified as breeding habitat. (One existing pond on the Griffith Ranch was determined to be unsuitable for CTS breeding [see Figure 2 in the MMP].) There may be additional breeding sites that are off of these lands. Evaluation of Phase II construction and mitigation protection for lands surrounding these ponds could produce both positive and negative consequences for CTS habitat value. We have

no information about such potential sites, nor do we have any indication of future plans for protecting such sites; therefore, it is impossible to include them in any calculations in a meaningful way.

Finally, we emphasize that the Director's Guild property, in our opinion, should **not** be considered as mitigation property at the present time. It is isolated from all known breeding site, and the playa pool on the site has been sampled several times (see LSA memorandum, April 18, 2007) with no evidence of CTS breeding across multiple years. Proposing that it would serve as an effective relocation site for displaced animals seems completely inappropriate, given that it has not yielded successful breeding in 2005, 2006, or 2007. The playa pool and associated regions may have conservation value for other taxa, but the sampling that has been conducted to date support the interpretation that it **does not support successful breeding of CTS, and there is no reason to suspect that relocated animals will thrive or breed at the site.** We agree with the LSA conclusion that natural playa pools can be more important breeding sites than artificial stock ponds, and we also agree that many playa pools in the vicinity (Olcott Lake at Jepson Prairie, Wilcox Ranch, and others) support important populations of CTS. However, all available evidence suggests that the Director's Guild playa pool does not. It was sampled in 2 years when other pools, both the aforementioned natural playa pools at Jepson Prairie and the adjacent stock pools in the Potrero Hills site, supported successful breeding, and it failed to do so. We strongly believe that the evidence provided by LSA directly contradicts the conclusion that the Director's Guild and its associated playa pool habitat should be considered CTS mitigation habitat.

**Other Direct Effects.** Other direct effects that we cannot address quantitatively, because we do not know their magnitude, include increased road traffic, the isolating effects of roads on the remaining terrestrial habitat, any losses due to pollutant leakage from the landfill, and several other potential negative effects. Although we cannot address these effects quantitatively, we note the following qualitative concerns regarding these other potential effects:

- Increasing the period of landfill activity to 24 hours per day will result in a more constant flow of road traffic across the landscape and increased night traffic, compared to existing operations. CTS adults migrate exclusively after dark on rainy nights, and young metamorphs migrate at night between April and July, either during rare rain events or as the pond dries (optimal migration times at Jepson Prairie appear to be from 3 to 6 AM, although they will move at any time during the night). This 24-hour road traffic may constitute a major impact to CTS as they move to and from their upland retreats.

- Increasing night lighting also may affect migrating CTS. We know that CTS never migrate during the daytime, suggesting that bright lights could confuse migrating animals. However, no data are available to address this issue.

- It should be made clearer how construction activities will go forward with no impact on burrow activities or other impacts on protected areas (Table 2-1, Component 4e). In particular, where will dirt be placed as the expansion area is built out? If it will be placed on the Eastern Valley parcel due east of the expansion area, then that area will need to be considered as “lost” acreage. If all dirt and earth-moving activities will somehow be limited to the expansion area, that should be explained more fully.

- We strongly recommend that ground squirrel control measures be prohibited on the entire site, in perpetuity. Ground squirrels are a key component of upland habitat for CTS, and eliminating them degrades the terrestrial habitat.

## Indirect Effects

Because healthy salamander populations exist in close proximity to the existing Phase I landfill, we assume that indirect effects of landfill operations are minor. However, any changes in water availability and quality, grazing management, or rodent control could affect CTS. Such changes would need to be evaluated on a case by case basis since their effects are unknown. In addition, eliminating existing rodent control (if it currently occurs) could produce a net benefit to salamanders and could constitute a positive mitigation action. Our model, however, does not quantify the benefits from this or other habitat management factors.

## Cumulative Effects

Obviously, development is a key ingredient in the decline of CTS. In a multi-factor evaluation of eight declining amphibians in California, CTS were found to be primarily declining due to local habitat loss—this factor explained losses more completely than pesticide drift, climate change, or large-scale habitat loss (Davidson et al. 2002). The landfill project is part of the general development of vernal pool habitat in Solano County, and that larger set of development projects is an enormous threat to the species. These larger scale effects are being addressed through the ongoing Solano County Habitat Conservation Plan (LSA Associates 2007), but we have not reviewed the proposed plan to judge its adequacy in addressing large-scale effects.

# MITIGATION EVALUATION

(Note: We include some mitigation evaluation in "Impact Evaluation" above.)

## Key Elements of the Mitigation Program

As stated in the reports provided to us, the goal of the Mitigation Program is to achieve a 2:1 mitigation ratio of gained to lost habitat for CTS. This is accomplished by protecting acreage and creating new ponds to replace lost ponds. The exact mitigation ratio for a site, as discussed by the USFWS (USFWS 2003), depends on the site, its biological value to the species, and other negotiable factors.

## Evaluation of the Mitigation Program

**Mitigation Goals.** In general, we believe that the stated or implied mitigation goals, if they were met, would be fairly reasonable. We feel that a minimum 2:1 ratio of acre-equivalent credits gained through mitigation (preservation): lost is reasonable. We feel that a 3:1 ratio would better reflect the value of this area, given its proximity to the Bay Area (where available habitat is rare and expensive); its isolation from other regions; and the intact, healthy, metapopulation-like nature of the existing landscape. Thus, we feel that a 3:1 ratio is most appropriate, but we can accept a 2:1 if the Landfill and USFWS agree to this value.

**Mitigation Actions.** As detailed above, *we do not believe that the mitigation actions are sufficient as replacement for the lost habitat in the project, let alone any net improvement*. That is, based on the calculations provided in Table 4-2, the proposed mitigation lands do not meet a 1:1 mitigation ratio, let alone a 2:1 or 3:1 ratio. The Phase II expansion onto the proposed site is very damaging biologically from the perspective of CTS terrestrial habitat. As emphasized above, this is not simply a matter of acreage lost but of the placement within the landscape of those acres. Other potential locations for the Phase II expansion might lead to greater connectivity of the proposed mitigation parcels and a more positive final outcome. However, with the current configuration, the Eastern Valley parcel plus some additional acreage is required to reach a 1:1 ratio, and considerably more to reach a 2:1 or 3:1 ratio. We cannot say exactly what that additional acreage might be, because it depends on where it is with respect to existing ponds.

An important aspect of our method of evaluating mitigation is that we do not give credit for the terrestrial habitat that might increase in value with the creation of new ponds. As discussed above (see "Direct Project Effects"), we do not consider the added potential benefits of any created wetlands because we do not currently understand how they might, or might not, contribute to the overall population size and viability of the entire site. This strategy is in line with the recommendations of USFWS (2003), which states that "the [conservation] credits should be based on the biological values of the bank *at the time the bank agreement is established* (p. 9, italics added). We feel that it is reasonable to ask the applicant to try out the establishment of new ponds on the site, since they already own and manage the property under consideration.

If the application is approved, and the improvement of new sites is a condition for that approval, then monitoring of current and future population sizes should be an integral part of ongoing management. We believe that, if proposed new ponds were established, and if they contribute in an additive manner to the total number of breeding adults at the entire site, then they should count for additional credits. We are most comfortable seeing this done before the landfill expansion occurs, but we realize that it could be done, and monitored, concurrently with the landfill expansion. This could be an important research goal for the next several years. Depending on the outcome of such research, it could be that placing ponds strategically within mitigation areas could significantly alter the cost-benefit analysis presented in Table 4-2. One simple way to consider this would be to keep the current value of 178.03 acres/pond constant. This would allow for one new pond in the Southern Hills, and one on the Griffith Ranch parcel. The Director's Guild, which is less than half of the 178.03 acres, we consider to be too small to support a pond on its own.

Two final points are worth noting. In Table 2-1 and elsewhere, the Project EIR states that the dilapidated barn west of pond 5 provides upland habitat for CTS. We know of no evidence, anywhere, to suggest that this is true in anything other than the most trivial sense (that is, a migrating salamander might occasionally spend a day under a board, but even that is rare). The barn can be left to collapse or be hauled away, but it should not be counted as salamander habitat or mitigation.

Also, Table 2-1 in the Project EIR states that a biological monitor will watch for unearthed CTS and "relocate" them. We recommend that this measure be eliminated as unnecessary and excessively costly, because there is no obvious place to locate them, the possibility of actually seeing an animal is slight, and there is no empirical evidence that relocated animals actually survive and reproduce. If the Landfill has such evidence, then we might change this recommendation. As stated previously, we do not agree that the Director's Guild qualifies as such a site.

**Adequacy of Mitigation in Avoiding, Mitigating, and Compensating for Project Impacts.** According to our calculations, the proposed mitigation is inadequate to compensate for the very considerable project impact on CTS.

## Mitigation Recommendations

In Table 2-1 and elsewhere in the Project EIR, there is a discussion of differential mitigation ratios depending on the quality of the habitat to CTS. Because we provide a much more detailed and biologically based rationale for precise mitigation ratios, we strongly recommend that these ratios from Table 2-1 be removed and that our credit/loss system be adopted. If this is done, there is still the issue of deciding whether a 2:1, 3:1, or some other mitigation ratio is most appropriate. As stated previously, we believe that a 3:1 is most appropriate but can agree to a 2:1 if USFWS feels that is reasonable.

According to our calculations, the current project falls below a 1:1 ratio of gains to losses. We see two ways to bring the terrestrial habitat component of this project to a no net loss for CTS. If the goal is an overall net gain (2:1 or 3:1), even more mitigation would be required.

First, the proposed area for Phase II expansion could be moved to a different parcel within the total footprint of the entire property. Moving the expansion area (or reducing its size to avoid Ponds 3a and 4) could reduce effects compared to its current placement. Based on our evaluation method, moving the Phase II expansion to a less central site that eliminates fewer currently occupied ponds would provide considerable improvement in the mitigation value of the proposed parcels, which could accomplish a great deal for CTS mitigation.

Second, the Phase II expansion could be left where it is, but more land could be added for mitigation. Adding the Eastern Valley parcel would help but would not accomplish the mitigation needed to compensate for the Phase II expansion (i.e., adding it will not bring the project to a 1:1 ratio, see Table 4-2). We cannot comment on any other mitigation areas, because we would first need to evaluate their habitat values, acre by acre. However, we can do so if we are provided with the necessary information relating to the location of these areas and the location and size of any salamander breeding sites in these areas.

Other mitigation considerations follow.

- We strongly recommend that ground squirrel population control be eliminated on all mitigation areas. This action could provide a positive benefit for CTS by increasing the terrestrial habitat quality, although this benefit has never been demonstrated to our knowledge. A quantitative evaluation of the effects of diminished ground squirrel control could be identified as a research topic for the next few years, to clarify the extent of these benefits, if any. One simple way to evaluate this would be to count the density of ground squirrel burrows and determine whether they increase—if so, this might serve as a proxy for CTS terrestrial habitat value.

- Monitoring is a key element of any mitigation plan. As modifications to the existing landscape occur, it is critical to conduct long-term monitoring, ideally of adults and larvae, to track population health and the efficacy of management actions. Given that CTS live and breed for about 10 years (Trenham at al. 2000), these monitoring efforts should be ongoing for the life of the landfill project (which is several CTS generations).

- In Project EIR Table 2-1, Component 4 (a "salamander-proof barrier") is proposed around the expansion area. While we view this as a reasonable requirement, and potentially important safeguard, there are no details on height or a maintenance schedule for the barrier. Such barriers, in our experience, require frequent cleaning and maintenance in order to be effective. An effective barrier should be solid and permanent; we recommend a 2- to3-foot tall concrete retaining wall. It will need regular cleaning and maintenance to keep soil, debris, leaf litter and other material from building up along it.

- We have discussed the possibility of conducting additional research on CTS aquatic and terrestrial ecology at the Potrero Hills site. Although our research plans do not directly address the research needs identified in this report, our work will provide valuable insights based on detailed, multi-year work on food web dynamics in both aquatic and terrestrial stages of the animals. We hope that this work can go forward, in the spirit of cooperation discussed during our first meeting.